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This TechData Sheet is intended to help activity personnel identify cost effective energy projects for energy projects for Adjustable Speed Drives (ASDs). With this guide an energy manager can identify when an ASD is applicable and do a first-run evaluation of the project payback.

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TechData Sheet

Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4328

TDS-2011-E&U *January 1995*

Adjustable Speed Drives

This TechData Sheet is intended to help activity personnel identify cost effective energy projects for Adjustable Speed Drives (ASDs). With this guide an energy manager can identify when an ASD is applicable and do a first-run evaluation of the project payback.

HOW ASDs WORK

ASDs are sometimes referred to as variable speed drives or variable frequency drives. Regardless of the name, ASDs are devices that control the speed and torque of the shaft on a motor. With this control, a motor is run at the appropriate operating speed for the involved process. Varying the speed of the motor to match the needs of the process, rather than operating the motor at maximum speed, saves energy and reduces maintenance on the motor.

An ASD controls the speed of an AC motor by varying the voltage and frequency input. Figure 1 illustrates the operation of an ASD. The rectifier makes the negative half-cycle of the sinusoidal supply positive. The DC link filters high frequency to yield a smooth usable DC power source. The inverter uses the DC power source to supply the motor input power. The voltage and frequency adjusts to the torque and speed requirements for the motor to drive the process operating point. The regulator controls the inverter using equipment feedback signals and operator commands to maintain a usable voltage to frequency ratio.

ASD APPLICABILITY

Two conditions should exist for an Adjustable Speed Drive to be considered. One, the motor must use an AC supply, and two, the process load must

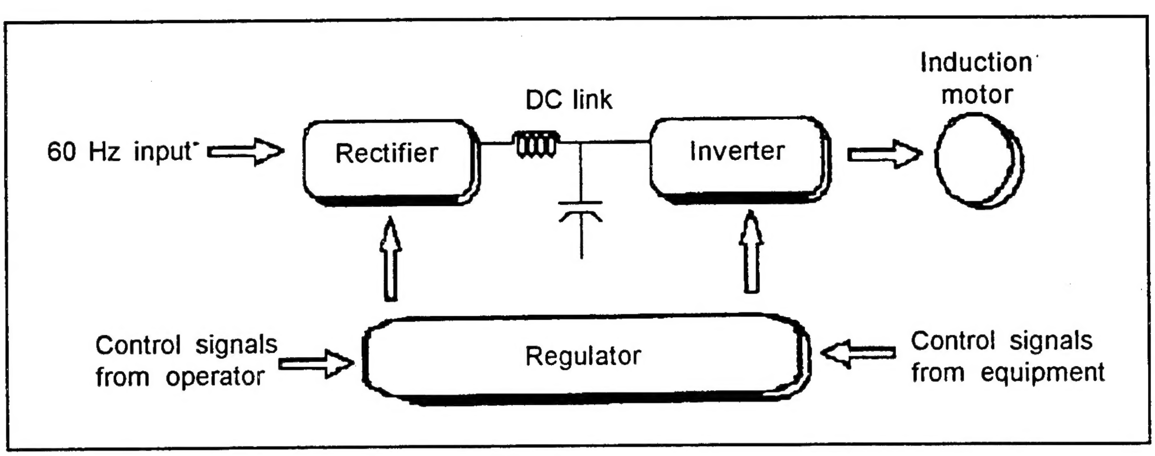

Figure 1. ASD Block Diagram

be variable (that is, the speed and torque required of the motor must vary).

Typical applications are fans, pumps and compressors. Fans on large air handling units are usually good candidates for ASD retrofitting provided that the system is variable air volume (VAV). Although reciprocating compressors cannot be retrofitted, centrifugal compressors are excellent candidates for adjustable speed control. In fact, some manufacturers offer compressors with ASDs from the factory. Almost any distribution pump is likely to benefit from an ASD, for instance, salt water distribution pumps or high temperature hot water pumps.

Table 1 lists a variety of processes. Those marked with a ◆ are possible applications for a retrofit.

COST EFFECTIVENESS OF ASDs

Once you have determined that an ASD is applicable you need to evaluate the cost effectiveness of a retrofit. Table 2 is taken from the Electrical Power Research Institute (EPRI) Adjustable Speed Drives Directory and shows two typical motor use profiles, one for a fan and one for a pump.

Table 1. Adjustable Speed Drive Applications Matrix

MACHINE TYPES / PROCESS REQUIREMENTS	BLENDERS	CONVEYORS	FANS	CRANES	SANDERS	DRUM BARKERS	LATHES	MILLING MACHINES	PLANERS	REWINDERS/SLITTERS	STOCK CLEANERS	MIXERS	FILTER PRESS	COMPRESSORS	TRAYS	SORTERS	DRYERS	FEEDERS	PUMPS	FORKLIFT	GRINDER	EXTRUDER
GAS AND LIQUID FLOWS			◆								◆		◆	◆			◆		◆			
MATERIAL HANDLING		◆		◆									◆		◆	◆		◆		◆		
CHEMICAL PROCESSES	◆											◆	◆									
MACHINING/FABRICATION					◆	◆	◆	◆	◆						◆						◆	
PRECISION/FINISH					◆		◆	◆	◆	◆					◆						◆	
MASS FLOW RATES	◆	◆	◆							◆								◆	◆			◆
PRODUCTION CONTROL	◆	◆			◆	◆	◆	◆	◆		◆	◆		◆		◆		◆				
WINDING/UNWINDING										◆												

	BLENDERS	CONVEYORS	FANS	CRANES	SANDERS	DRUM BARKERS	LATHES	MILLING MACHINES	PLANERS	REWINDERS/SLITTERS	STOCK CLEANERS	MIXERS	FILTER PRESS	COMPRESSORS	TRAYS	SORTERS	DRYERS	FEEDERS	PUMPS	FORKLIFT	GRINDER	EXTRUDER
HORSEPOWER: < 50	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
50 - 250			◆		◆		◆	◆	◆	◆	◆		◆	◆	◆	◆	◆		◆	◆	◆	
> 250						◆				◆		◆	◆	◆	◆	◆	◆	◆	◆			
MOTOR TYPES: INDUCTION	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
SYNCHRONOUS														◆								
SPEED RANGES: < 1000 RPM	◆	◆		◆		◆	◆	◆		◆		◆	◆		◆	◆	◆	◆	◆	◆	◆	◆
1000 - 2000 RPM	◆	◆	◆		◆				◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
> 2000 RPM		◆	◆		◆		◆	◆	◆													
VOLTAGE LEVEL: < 600 V	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
1000 - 5000 V						◆		◆	◆	◆		◆	◆	◆								
> 5000 V													◆	◆								
TORQUE REQUIREMENTS: HIGH	◆	◆		◆		◆				◆		◆	◆		◆			◆		◆		
LOW	◆	◆		◆		◆				◆		◆	◆		◆			◆		◆		
DUTY CYCLE: HIGH	◆			◆		◆	◆	◆		◆		◆	◆		◆	◆		◆		◆	◆	◆
LOW		◆	◆		◆				◆		◆			◆			◆		◆			
REVERSING		◆		◆						◆		◆			◆			◆		◆		
REGENERATIVE				◆						◆					◆					◆		
CONTROL STRATAGY: FLOW			◆								◆		◆	◆	◆	◆	◆	◆	◆			◆
SPEED	◆	◆		◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
PRESSURE			◆											◆					◆			◆
MULTIPLE DRIVE	◆	◆			◆				◆	◆		◆			◆	◆	◆	◆			◆	

Table 3 lists the kilowatt-hour rate necessary to provide a payback of less than 5 years for motor horsepowers ten through one thousand.

Using Table 3, find your motor horsepower in the first column, then see what kilowatt-hour rate will yield a payback under 5 years. If you pay more for a kilowatt-hour than the value indicated in Table 3, you most likely have a cost effective retrofit. These tables are approximations only but will indicate whether further investigation is warranted or not. The calculations in Table 3 do not include savings from demand reduction due to the complexity of the calculation and the number of variables involved. However, if the local demand rate is high and the motor use occurs during on-peak hours, it is possible to realize substantial demand savings.

If after reviewing the data in Tables 2 and 3 you feel you have a feasible project, contact your EFD or the Naval Facilities Engineering Service Center (NFESC) to assist you with validating the feasibility of the project and with the energy project documentation.

Technical Contact for ASDs

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Table 2. Typical Motor Use Profiles

Profile	Percent Load	Annual Hours at Load
Fan	0	2,500
	25	750
	35	250
	40	400
	50	1,200
	75	2,500
	90	800
	100	360
Pump	0	2,500
	40	100
	45	150
	50	200
	55	300
	60	250
	65	400
	70	1200
	75	2300
	80	400
	85	200
	90	100
	95	300
	100	360

Table 3. Payback Chart for Sample Motor ASD Projects

			Fan Load Profile 1*		Pump Load Profile 2*	
Motor Size	ASD Cost ($)	kW Used by by Motor**	kWh/Yr Saved	Lowest $/kWh for <5 Yr Payback ($)	kWh/Yr Saved	Lowest $/kWh for < 5 Yr Payback
10	7,500	7.85	17,000	0.09	17,900	0.08
20	13,000	15.71	33,000	0.08	35,800	0.07
30	18,000	23.56	50,000	0.07	54,000	0.07
40	20,000	31.41	67,000	0.06	72,000	0.06
70	28,000	54.97	117,000	0.05	125,000	0.04
100	30,000	78.53	167,000	0.04	180,000	0.03
150	48,000	117.79	250,000	0.04	270,000	0.04
200	64,000	157.05	333,000	0.04	360,000	0.04
300	94,000	235.58	500,000	0.04	540,000	0.03
400	112,000	314.11	667,000	0.03	720,000	0.03
1,000	205,000	785.26	1,667,000	0.02	1,800,000	0.02

*Estimated yearly profile.

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